

Smarter Lighting - ADB

Dr. Michael Hamm, AUDI AG

ADB and Market Introduction
Research for new Functionalities

ADB, Market and Digitalization Research

ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

ADB in USA



This document is scheduled to be published in the Federal Register on 10/12/2018 and available online at <https://www.federalregister.gov/d/2018-21853>, and on govinfo.gov.

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 571

[Docket No. NHTSA-2018-0090]

RIN 2127-AL83

Federal Motor Vehicle Safety Standards; Lamps, Reflective Devices, and Associated Equipment

AGENCY: National Highway Traffic Safety Administration ("NHTSA"), Department of Transportation ("DOT").

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This document proposes amendments to Federal Motor Vehicle Safety Standard ("FMVSS") No. 108; *Lamps, reflective devices, and associated equipment*, to permit the certification of adaptive driving beam headlighting systems, if the manufacturer chooses to equip vehicles with these systems. Toyota Motor North America, Inc. (Toyota) petitioned NHTSA for rulemaking to amend FMVSS No. 108 to permit manufacturers the option of equipping vehicles with adaptive driving beam systems. NHTSA has granted Toyota's petition and proposes to establish appropriate performance requirements to ensure the safe introduction of adaptive driving beam headlighting systems if equipped on newly manufactured vehicles.

DATES: You should submit your comments early enough to be received not later than [INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: You may submit comments to the docket number identified in the heading of this document by any of the following methods:



DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

49 CFR Part 571

[Docket No. NHTSA-2018-0090]

RIN 2127-AL83

Federal Motor Vehicle Safety Standards; Lamps, Reflective Devices, and Associated Equipment

AGENCY: National Highway Traffic Safety Administration ("NHTSA"), Department of Transportation ("DOT").
ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This document proposes amendments to Federal Motor Vehicle Safety Standard ("FMVSS") No. 108; *Lamps, reflective devices, and associated equipment*, to permit the certification of adaptive driving beam headlighting systems, if the manufacturer chooses to equip vehicles with these systems. Toyota Motor North America, Inc. (Toyota) petitioned NHTSA for rulemaking to amend FMVSS No. 108 to permit manufacturers the option of equipping vehicles with adaptive driving beam systems. NHTSA has granted Toyota's petition and proposes to establish appropriate performance requirements to ensure the safe introduction of adaptive driving beam headlighting systems if equipped on newly manufactured vehicles.

DATES: You should submit your comments early enough to be received not later than December 11, 2018.

ADDRESSES: You may submit comments to the docket number identified in the heading of this document by any of the following methods:

- **Federal eRulemaking Portal:** Go to <http://www.regulations.gov>. Follow the online instructions for submitting comments.
 - **Mail:** Docket Management Facility; U.S. Department of Transportation, 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12-140, Washington, DC 20590-0001.
 - **Hand Delivery or Courier:** 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12-140, between 9 a.m. and 5 p.m. ET, Monday through Friday, except Federal holidays.
 - **Fix:** 202-493-2251.
- Instructions:** All submissions must include the agency name and docket number. Note: All comments received will be posted without change to <http://www.regulations.gov>, including any personal information provided. Please

see the Privacy Act discussion below. We will consider all comments received before the close of business on the comment closing date indicated above. To the extent possible, we will also consider comments filed after the closing date.

Docket: For access to the docket to read background documents or comments received, go to <http://www.regulations.gov> at any time or to 1200 New Jersey Avenue SE, West Building Ground Floor, Room W12-140, Washington, DC 20590, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. Telephone: 202-366-9826.

Privacy Act: Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the **Federal Register** published on April 11, 2000 (Volume 65, Number 70; Pages 19477-78) or you may visit <http://www.dot.gov/privacy.html>.

Confidential Business Information: If you wish to submit any information under a claim of confidentiality, you should submit three copies of your complete submission, including the information you claim to be confidential business information, to the Chief Counsel, NHTSA, at the address given under **FOR FURTHER INFORMATION CONTACT**. In addition, you should submit two copies, from which you have deleted the claimed confidential business information, to Docket Management at the address given above. When you send a comment containing information claimed to be confidential business information, you should include a cover letter setting forth the information specified in our confidential business information regulation (49 CFR part 512).

FOR FURTHER INFORMATION CONTACT: Please contact Mr. Markus Price, 202-366-0098 or Mr. John Piazza, Office of Chief Counsel, Telephone: 202-366-2992, Facsimile: 202-366-3820. You may send mail to these officials at: The National Highway Traffic Safety Administration, 1200 New Jersey Avenue SE, Washington, DC, 20590.

SUPPLEMENTARY INFORMATION:

Table of Contents

- I. Executive Summary
- II. Background and Safety Need
- III. ECE ADB Regulations
- IV. NHTSA Research Related to ADB
- V. SAE J3069

- VI. Interpretation of How FMVSS No. 108 Applies to ADB
 - a. ADB Is Not Supplemental Lighting But Is Part of the Required Headlamp System
 - b. ADB Systems Would Not Comply With at Least Some of the Headlamp Requirements
 - i. Photometry Requirements
 - ii. Semi-automatic Beam Switching Device Requirements
 - c. Tentative Determination
- VII. NHTSA's Statutory Authority
- VIII. Proposed Requirements and Test Procedures
 - a. Requirements
 - i. Baseline Glare Limits
 - ii. Existing Photometry Requirements That Would Also Apply to ADB Systems
 - iii. Other System Requirements
 - iv. Retention of Existing Requirements for Semi-automatic Headlamp Beam Switching Devices Other Than ADB
 - b. Test Procedures
 - i. Introduction
 - ii. Test Vehicle and Stimulus Vehicle
 - iii. Considerations in Determining Compliance With the Derived Glare Limit Values
 - iv. Additional Test Parameters
 - c. Repeatability
 - IX. Certification and Aftermarket
 - X. Regulatory Alternatives
 - XI. Overview of Benefits and Costs
 - XII. Rulemaking Analysis
 - XIII. Public Participation
 - XIV. Appendix A to Part 571—Road Illumination and Pedestrian/Cyclist Facilities Proposed Regulatory Text

I. Executive Summary

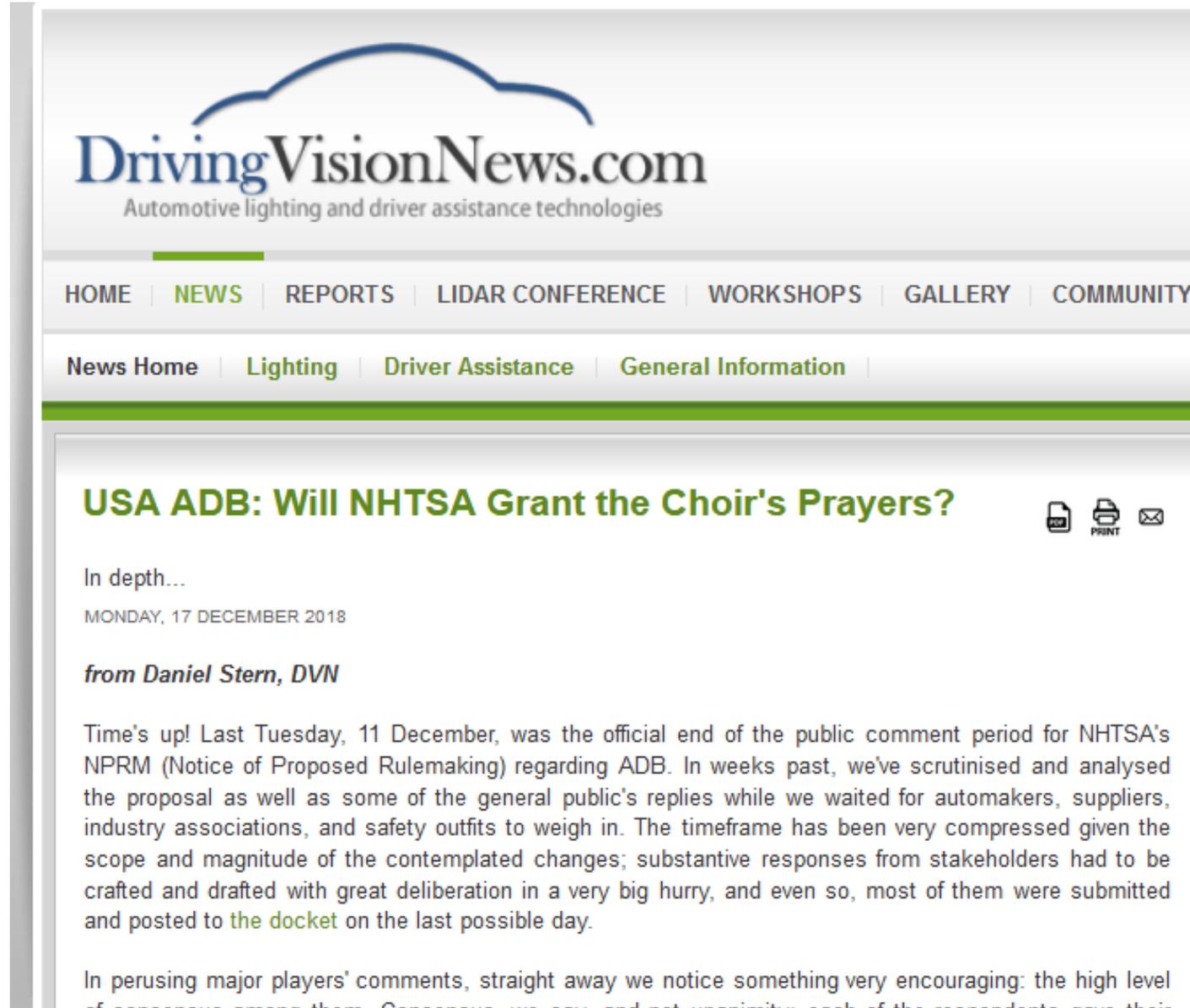
Glare, Visibility, and Adaptive Driving Beam Technology

This proposal is intended to allow an advanced type of headlighting system referred to as adaptive driving beam to be introduced in the United States. Adaptive driving beam ("ADB") headlamps use advanced technology that actively modifies the headlamp beams to provide more illumination while not glaring other vehicles. The requirements proposed today are intended to amend the existing regulations to permit this technology and ensure that it operates safely.

Vehicle headlamps must satisfy two different safety needs: visibility and glare prevention. The primary function of headlamps is to provide forward visibility. At the same time, there is a risk that intense headlamp illumination may be directed towards oncoming or preceding vehicles. Such illumination, referred to as glare, can reduce the ability of other drivers to see and cause discomfort. Headlighting has therefore traditionally entailed a trade-off between long-distance visibility and glare. This is reflected in the requirement that headlamp systems have both lower and upper beams. The existing headlight requirements regulate

Comments to NPRM issued:

Best summary:



The screenshot shows the website DrivingVisionNews.com, which focuses on automotive lighting and driver assistance technologies. The navigation menu includes links for HOME, NEWS, REPORTS, LIDAR CONFERENCE, WORKSHOPS, GALLERY, and COMMUNITY. Below this, there are sub-links for News Home, Lighting, Driver Assistance, and General Information. The main content area features an article titled "USA ADB: Will NHTSA Grant the Choir's Prayers?" dated Monday, 17 December 2018, written by Daniel Stern, DVN. The article discusses the public comment period for NHTSA's NPRM regarding ADB, noting that the timeframe was compressed and stakeholders had to submit comments quickly. The article is partially visible, showing the beginning of a paragraph.

DrivingVisionNews.com
Automotive lighting and driver assistance technologies

HOME | NEWS | REPORTS | LIDAR CONFERENCE | WORKSHOPS | GALLERY | COMMUNITY

News Home | Lighting | Driver Assistance | General Information

USA ADB: Will NHTSA Grant the Choir's Prayers?

In depth...
MONDAY, 17 DECEMBER 2018

from Daniel Stern, DVN

Time's up! Last Tuesday, 11 December, was the official end of the public comment period for NHTSA's NPRM (Notice of Proposed Rulemaking) regarding ADB. In weeks past, we've scrutinised and analysed the proposal as well as some of the general public's replies while we waited for automakers, suppliers, industry associations, and safety outfits to weigh in. The timeframe has been very compressed given the scope and magnitude of the contemplated changes; substantive responses from stakeholders had to be crafted and drafted with great deliberation in a very big hurry, and even so, most of them were submitted and posted to [the docket](#) on the last possible day.

In perusing major players' comments, straight away we notice something very encouraging: the high level of expertise across them. Consensus was rare, and not surprising, each of the respondents gave their

ADB, Market and Digitalization Research

ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

Today's most digital Light: Matrix LED

- › Matrix LED headlights are „Adaptive Driving Beams / Glare Free High Beam”
- › Each segment is individually dimmable and switchable
- › Camera detects other traffic. Image processing controls segments.
- › Traffic sign segments have reduced brightness.
- › Driver has always best available seeing distance

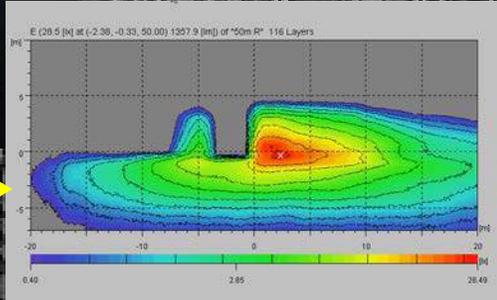
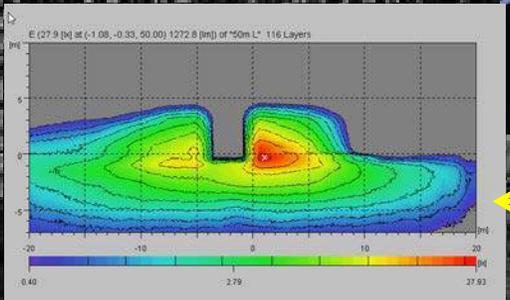


Prominent Matrix Member Frontlighting:

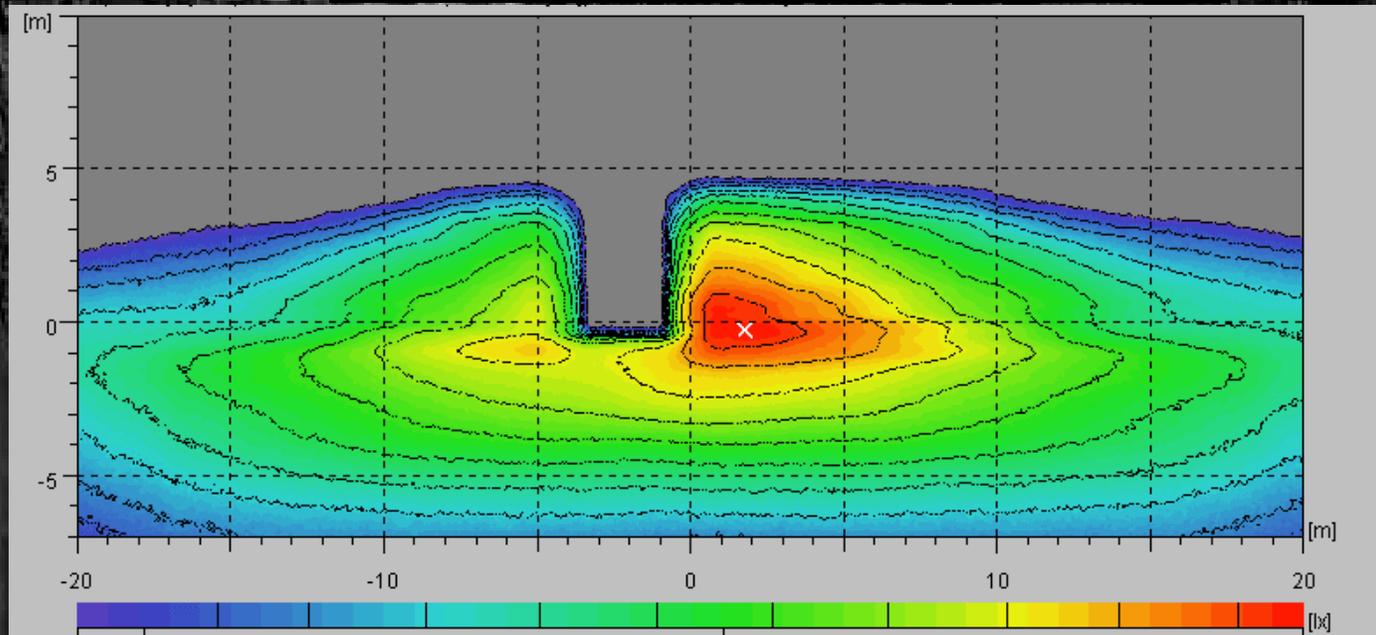


New Audi A8 Matrix

Audi A8 Matrix

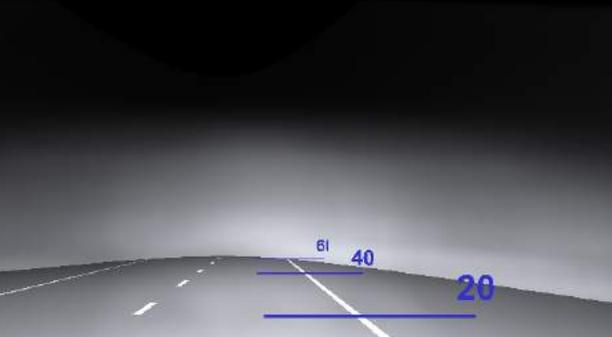


Oncoming car 50 m



Audi A8 Matrix

Full High Beam



125.2 lx at 5 m , Angle = -0.3 deg

1 volles Fernlicht
2016-11-30_D5MxB_ECE LH_MxB-ohneV - low beam
2016-11-30_D5MxB_ECE RH_MxB-ohneV - low beam

ADB, Market and Digitalization Research

ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

ECE Regulation 123: ADB Measurement in R.123, Table 7

E/ECE/324/Rev.2/Add.122/Rev.2-E/ECE/TRANS/505/Rev.2/Add.122/Rev.2

21 October 2013

Agreement

Concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these Prescriptions*

(Revision 2, including the amendments which entered into force on 16 October 1995)

Addendum 122: Regulation No. 123

Revision 2

Incorporating all valid text up to:

Supplement 1 to the 01 series of amendments - Date of entry into force: 28 October 2011
 Corrigendum 1 Supplement 1 to the 01 series of amendments - Date of entry into force: 28 October 2011
 Supplement 2 to the 01 series of amendments - Date of entry into force: 26 July 2012
 Supplement 3 to the 01 series of amendments - Date of entry into force: 18 November 2012
 Supplement 4 to the 01 series of amendments - Date of entry into force: 15 July 2013

Uniform provisions concerning the approval of adaptive front-lighting systems (AFS) for motor vehicles



UNITED NATIONS

* Former title of the Agreement: Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

E/ECE/324/Rev.2/Add.122/Rev.2
E/ECE/TRANS/505/Rev.2/Add.122/Rev.2
Annex 3

Table 7
Requirements concerning the adaptation of the driving-beam according to paragraph 6.3.7. of this Regulation

Part A	Test point	Position / Deg.		Max. intensity** (cd)
		Horizontal	Vertical	
	Line 1 Left Oncoming vehicle at 50 m in the case of right-hand traffic	4.8°L to 2°L	0.57°Up	625
	Line 1 Right Oncoming vehicle at 50 m in the case of left-hand traffic	2°R to 4.8°R	0.57°Up	625
	Line 2 Left Oncoming vehicle at 100 m in the case of right-hand traffic	2.4°L to 1°L	0.3°Up	1 750
	Line 2 Right Oncoming vehicle at 100 m in the case of left-hand traffic	1°R to 2.4°R	0.3°Up	1 750
	Line 3 Left Oncoming vehicle at 200 m in the case of right-hand traffic	1.2°L to 0.5°L	0.15°Up	5 450
	Line 3 Right Oncoming vehicle at 200 m in the case of left-hand traffic	0.5°R to 1.2°R	0.15°Up	5 450
	Line 4 Preceding vehicle at 50 m in the case of right-hand traffic	1.7°L to 1.0°R >1.0° R to 1.7°R	0.3°Up	1 850
	Line 4 Preceding vehicle at 50 m in the case of left-hand traffic	1.7°R to 1.0°L >1.0° L to 1.7°L		1 850
	Line 5 Preceding vehicle at 100 m in the case of right-hand traffic	0.9° L to 0.5°R >0.5°R to 0.9°R	0.15°Up	5 300
	Line 5 Preceding vehicle at 100 m in the case of left-hand traffic	0.9° R to 0.5°L >0.5°L to 0.9°L		7 000
	Line 6 Preceding vehicle at 200 m in the case of left-hand traffic and right-hand traffic	0.45°L to 0.45°R	0.1°Up	16 000

ADB, Market and Digitalization Research

ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

Matrix LED in Series production (2018)



Audi A8



Audi TT



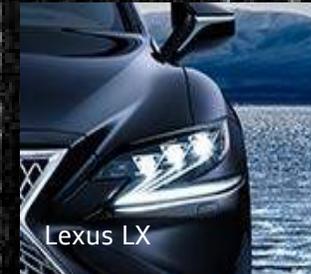
Porsche Panamera



Mazda CX-5 & 6



Land Rover Velar



Lexus LX



Audi A5



Audi A6



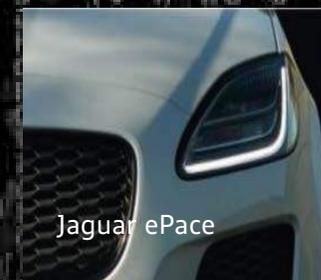
Mercedes CLS-Class



Mercedes E-Class



Mercedes S-Class



Jaguar ePace



Audi A7



Audi A3



Opel Astra



Opel Insignia



Roewe RX5



VW Touareg



Audi A4



Audi Q5



Audi Q7



Audi e-tron

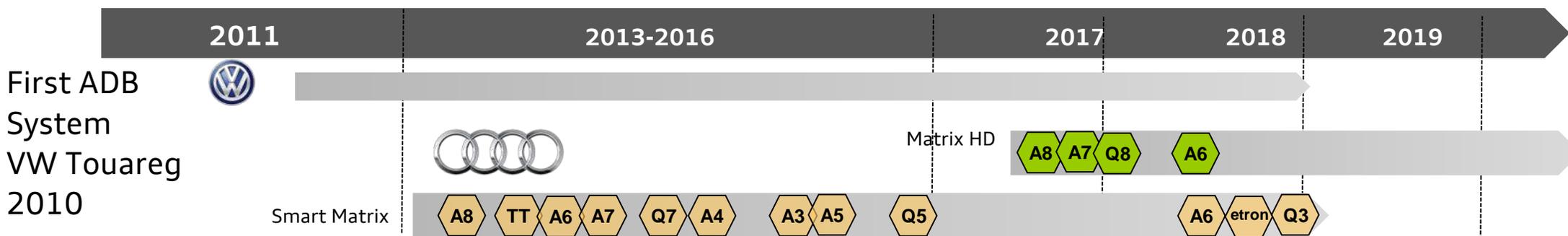
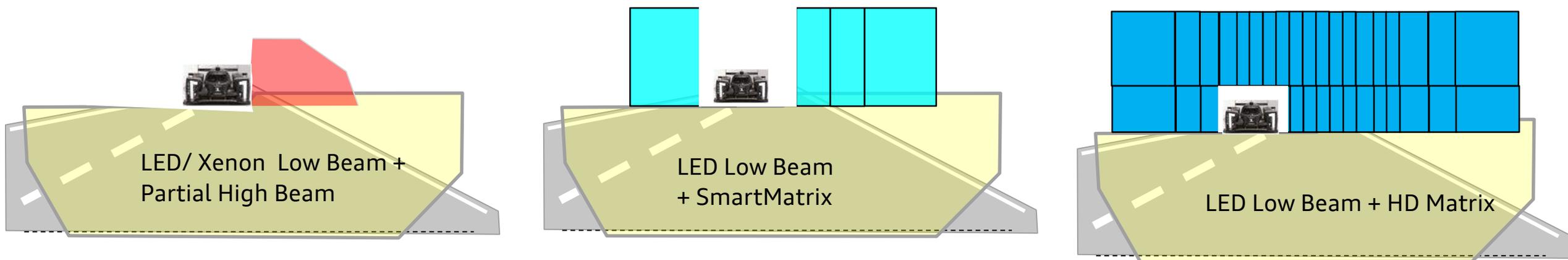


Audi A8



BMW Mini

ADB and Matrix: Many Solutions



Many ADB names have been invented

- Adaptive LED Headlights
- Active High Beam
- Dynamic Light Assist
- High Beam Control
- Intelligent Light System
- Maskiertes Dauerfernlicht
- Matrix LED
- Multibeam

Many ADB names have been invented



MULTIBEAM LED
2.320,50 Euro
Kaufpreis ab Werk



MATRIX-LED

Diese markanten Matrix-LED-Scheinwerfer mit LED-Signatur imitieren das natürliche Tageslicht, um Müdigkeit vorzubeugen, und bieten gleichzeitig eine exzellente Ausleuchtung der Fahrbahn. Für die bestmögliche Ausleuchtung passt das adaptive Beleuchtungssystem das Abblendlicht an Ihre Geschwindigkeit und die Wetterbedingungen an. Das intelligente Fernlicht mit Abblendautomatik nutzt eine nach vorne gerichtete Kamera, um entgegenkommende Fahrzeuge zu erkennen, und reguliert das Fernlicht, indem es einen Schatten um sie erzeugt. So können Sie weiterhin das Fernlicht zur Ausleuchtung der Straße nutzen, ohne andere Fahrer zu blenden.

KONFIGURATOR



mazda ABOUT INNOVATION NEWS CSR INVESTORS CAREERS



Multibeam

Worldwide Cars available with ADB



AUTOMOTIVE

Light Vehicle Sales Forecast

Drive better business decisions with insights into market demand, segment growth, and competitive dynamics.



Unrivalled detail for 97% of the world's light vehicle sales

The Light Vehicle Sales Forecast is built on a thorough examination of the automotive industry from a demand perspective. Using a disciplined forecasting methodology, our expert team of industry analysts marries macroeconomic and statistical analysis with segment trends, brand strategies, model life cycle stages, future model plans, consumer behaviors, and production capacity constraints. Clients use the forecast to analyze

OEMs

- Sales volume planning
- Market trends
- Segment trends
- Competitive product intelligence
- Competitor market entry timing
- Market share assessment

Suppliers

- OEM customer growth analysis
- Segment trends for supplied component and technology adoption
- Regional adoption paths for supplied component and technology growth

Financial institutions

- OEM financial success

Government agencies

- The size of domestic markets
- Taxation revenue forecasts
- Formulation of safety and emissions regulations

Logistics companies

- Sales destinations mapped to production source
- Unit volumes and frequency of shipment for revenue and capacity forecasts
- Vehicle container sizing

Estimated Produced Volumes with ADB content (basic source IHS Database) (New Cars or respective Facelifts from 2013...2018)

Audi	A8 (MY2013)	146000
	A8 (MY2017)	31000
	Q8	28000
	A7 (MY2014)	103000
	A7 (MY2018)	25000
	Q7	260000
	A6 (MY 2015)	320000
	A6 (MY2018)	75000
	Q5	330000
	A5	190000
	A4	1030000
	A3	460000
	Q3	23000
	TT	182000
	Audi e-tron	5000
3208000		

BMW:	7-series	286000
	6-series	66000
	5-series	487000
	4-series	398000
	3-series	1033000
	2-series	147000
	1-series	514000
	Mini	192000
	X6	93000
	X5	415000
	X4	112000
	X3	145000
3888000		
Mercedes:	S-Class	484000
	S-Class Coupe	38000
	CLS-Class	36000
	E-Class	1183000
	C-Class	161000
	GLE	58000
	GLC	178000
	V-Class	129000
2267000		

Opel/PSA:	Insignia	262000
	Astra	780000
	Citroen DS3	52000
1094000		
Volvo:	XC90	169000
	S90	62000
	XC60	71000
	S60	55000
	V40	184000
541000		

VW:	Touareg	45000
	Arteon	63000
	Passat	404000
	CC	88000
	Tiguan	727000
	Sharan	80000
	Touran	453000
	Golf	1137000
2997000		
Others	Mazda	270000
	Jaguar/Landrover	335000
	Lexus/Roewe et al.	100000
705000		

Estimated Total produced cars with ADB as an option:

14.700.000 cars (2013..2018)

Mathematics

- **Total produced cars:** 14.600.000
- *Estimated Equipment rate:* 10%
(conservative approach)
- **Total cars on roads in ECE and China:** 1.460.000

More calculation:

Average kilometers per car EU : 12.000km / a
 (Germany was 14.259km/a)
 (source enerdata 2019, AutoMotorSport)

Total driven kilometers with ADB cars /(2018): 17.640.000.000 = 17.64 billion kilometers

Assumption: Kilometers driven at night: 33%

Total driven kilometers

at NIGHT with ADB cars /(2018): 5.821.200.000

= 5,82 billion kilometers



Summary Statistics

- › ECE R. 123 requires measurement of ADB functionality
- › ECE R.48 requires ADB functionality test

- › More than 5 billion kilometers driven at night with ADB cars
- › All cars have passed ECE/China homologation

- › **Not a single field recall or regulation authorities investigations about Malfunctioning ADB**

- › **ADB according to ECE R.123 has passed the largest imaginable field test**

- › (shy question 😊)
Why do we need more and incredibly complex measurements ?

ADB, Market and Digitalization Research

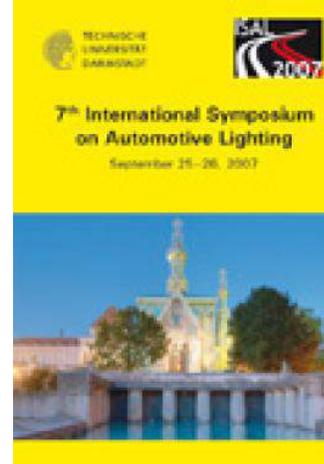
ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

ISAL 2007 Accident Study Data & Method



carried out by TÜV Rheinland , Germany

Database:

Accident data from DESTATIS* on German roads (1995 – 2005)

- › Divided in different road types (*rural roads, highways and city roads*)
- › Considering the external illumination (*day vs. night*)
- › Splitted in two groups of cars
 - › models with high Xenon take-rate (*increasing from 5% to 60% in the given period*)
 - › models with nearly no Xenon called “halogen cars” (*Xenon take-rate ~1% and lower*)

Take-rate information from second-hand car market in Germany

Method:

Eliminate all non-lighting-related factors in the analysis by using the night-time to daytime accident ratio (*e.g. ESP is working at night and day and does not influence the ratio*)

Source:

Schäbe, D.; Schierge, F.: Investigations on the influence of car lighting on nighttime accidents in Germany.

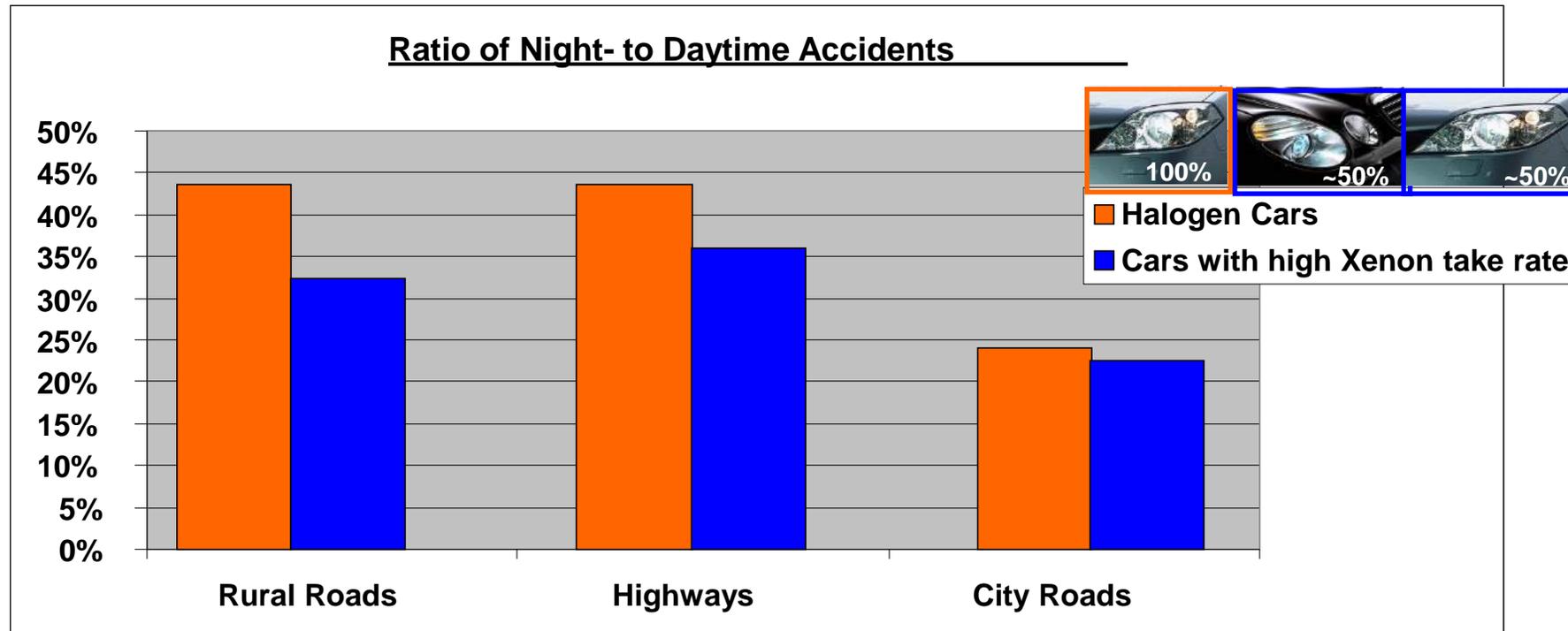
In: ISAL 2007, p. 1-5. UTZ Verlag Wissenschaft, München 2007.



* „Statistisches Bundesamt” in Germany

2007 Study Results

Source:
Schäbe, D.; Schierge, F.: Investigations on the influence of car lighting
on nighttime accidents in Germany.
In: ISAL 2007, p. 1-5. UTZ Verlag Wissenschaft, München 2007.



On rural roads and highways the 'Night-to-Day-Ratio' was significantly lower for the group of cars with high Xenon take rate.

For the group of cars with high Xenon take rate the risk of having a night time accident was clearly lower: -25% on rural roads and -17% on highways !!

The effect on city roads is small due to the quite high road illumination (which proves the applied statistical method !)

Consequences

Source:
Schäbe, D.; Schierge, F.: Investigations on the influence of car lighting
on nighttime accidents in Germany.
In: ISAL 2007, p. 1-5. UTZ Verlag Wissenschaft, München 2007.

Regarding the total car fleet, the Xenon penetration is still quite low
(~10% in Germany, << 10% in Europe).

Based on the results of the TÜV study a full switch from 100% Halogen to 100% Xenon in ...

... Germany 

- › ... would avoid more than 50% of night-time accidents on rural roads.
- › ... would inhibit 24% of all night-time accidents
(-25.000 crashes, - 1.100 deaths based on 2001).
- › ... would avoid 7% of all accidents and **16% of all fatalities.**

... Europe 

(assuming that the German situation is fully transferable)

- › ... would prevent 130.000 injuries a year *(based on EU-25 in 2001).*
- › ... would save **more than 8.000 fatalities** per year *(based on EU-25 in 2001).*

ADB, Market and Digitalization Research

ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

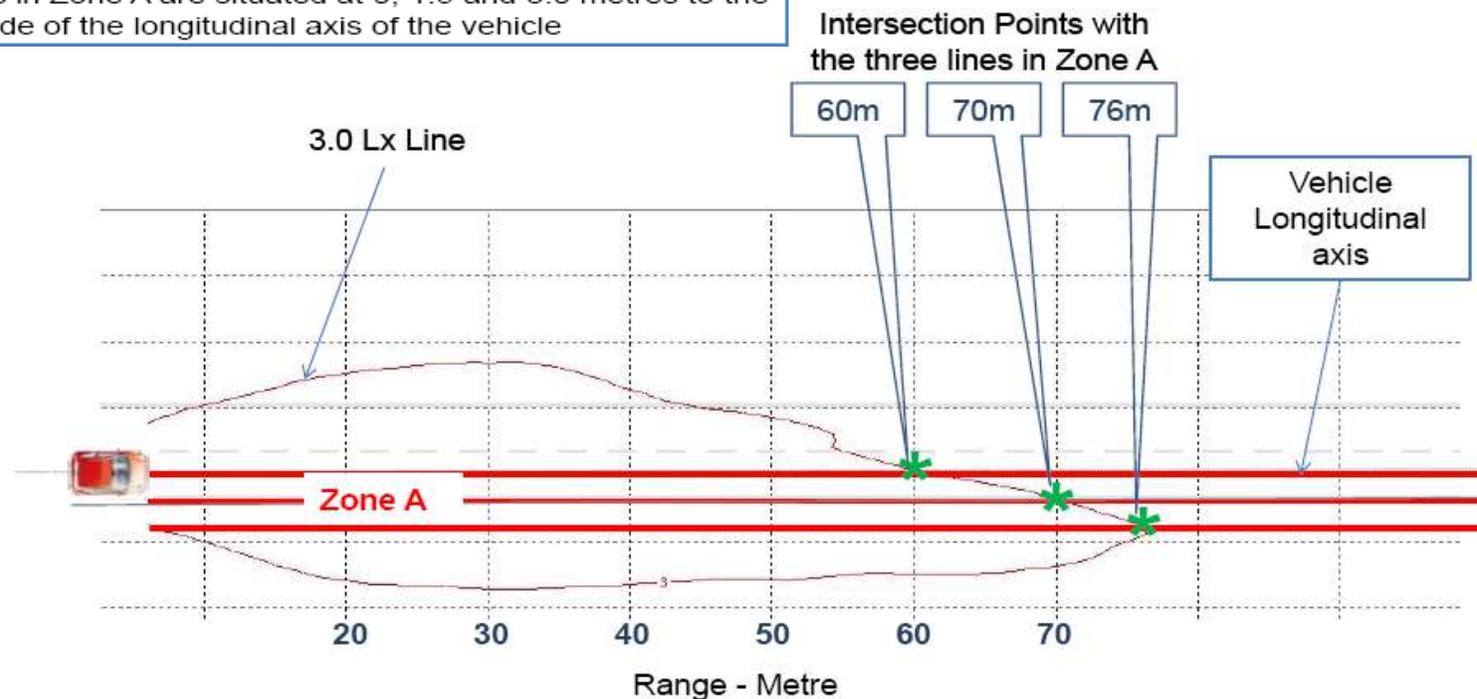
Data Comparison of Range: CIE TC 4-45

TC 4-45: Performance Assessment Method for Vehicle Headlamps

To produce a technical report with the objective of subsequently developing a standard that defines an objective procedure for the evaluation of forward-lighting system performance in terms of active safety. The work carried out by the former GTB EuroNCAP taskforce constitutes the basis for this development. Chair: [Karsten Köth \(DE\)](#)

The longitudinal lines in Zone A are situated at 0, 1.5 and 3.0 metres to the nearside of the longitudinal axis of the vehicle

© CIE 2000 - 2010 | CIE Central Bureau, Kegelgasse 27, A-1030 Vienna, Austria

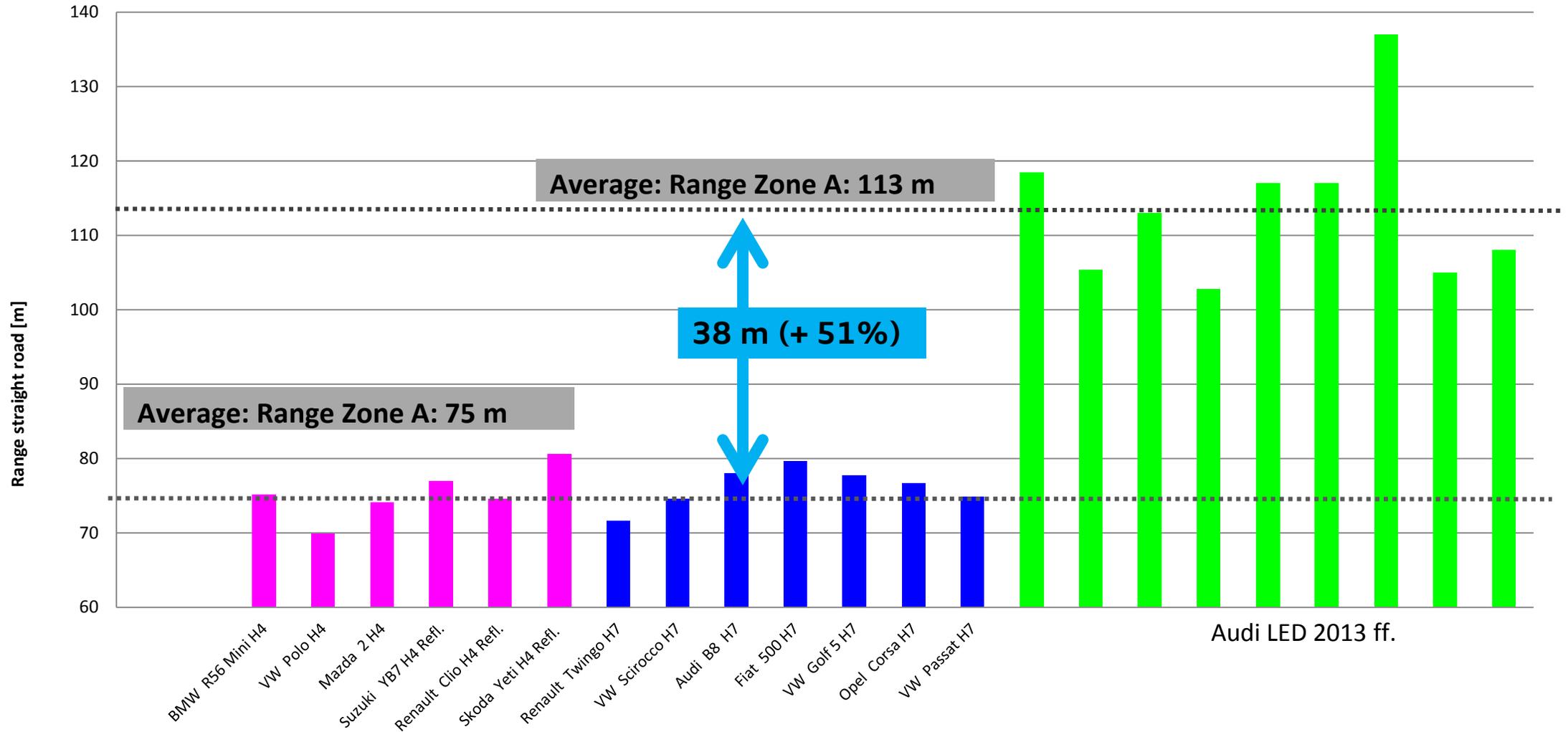


Range = average of intersections of 1 lx, 3 lx and 5 lx isolux lines with longitudinal lines

3 lx are the threshold to recognise road features, pedestrians or obstacles (with a reflectance of 4%)

Zone A Halogen (H4 & H7) vs. Today's LED systems

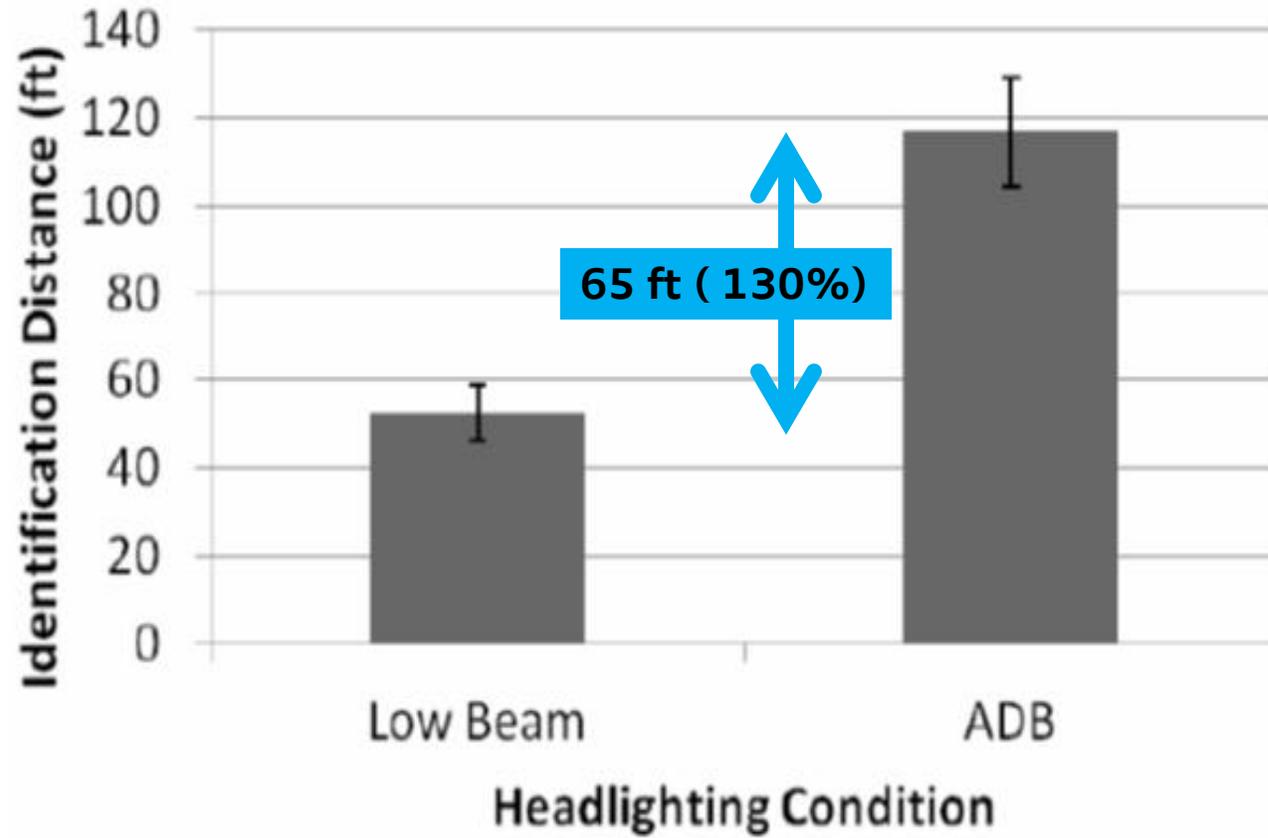
Zone A



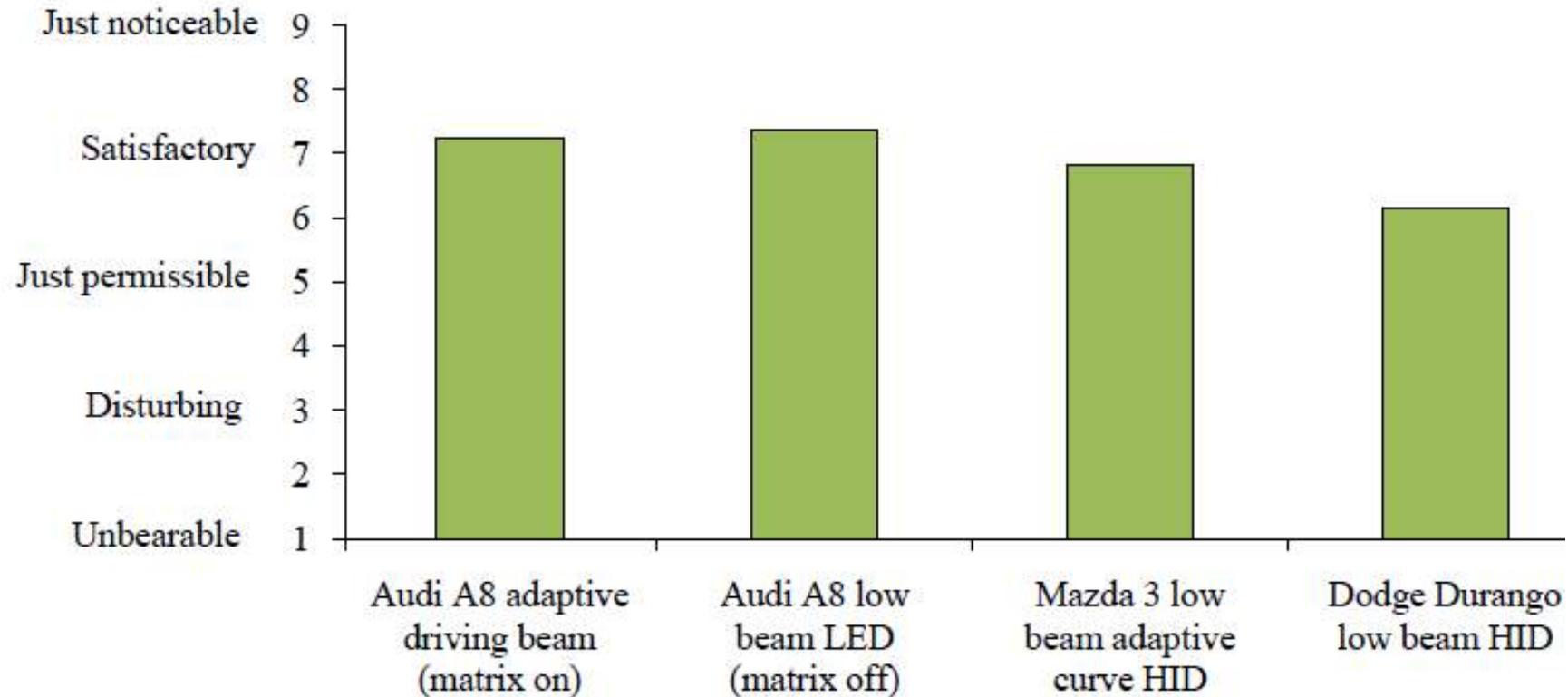
Average Detection Distances for different traffic situations (Static Evaluation) [Kleinkes 2013]

Setting		Avg. detection distance /m	Std. dev / m
Preceding Car @150m	Low Beam	85	14,3
	ACOL	100	
		45 m (+ 52%)	
	Glare free HB / MXB	130	13,0
Oncoming car @100m	Low Beam	82	11,0
	ACOL	128	
		57 m (+ 69%)	
	Glare free HB / MXB	139	15,6

'Object Identification [Bullough 2016]



DeBoer Ratings for three low beam and activated MatrixBeam (ADB) system. [Reagan 2015].



Source: Reagan, I.J., Brumbelow, M.L.: "Perceived discomfort glare from an adaptive driving beam headlight system compared with three low beam lighting configurations". Proc. 6th International Conference on Applied Human Factors and Ergonomics (AHFE 2015) and the Affiliated Conferences, AHFE 2015. pp.3215-3221

Summary ADB, Range and Detection

- › Modern LED lamps have about **50%** higher Zone A (TC 4-45) rating than Halogens.
- › ADB systems can deliver **50..130%** more Detection resp. Object detection distance than LED.
- › (ECE) LED systems and (ECE) ADB systems produce less glare than conventional (US) Xenons
- › **It can be assumed that ADB systems have even better impact on traffic safety than only Xenon**
- › **ADB systems are on the market since 2010**

OECD Statistics on Road Fatalities 1994...2016

Aktuelle News, Schlagzeilen Transport - Road accidents

https://data.oecd.org/transport/road-accidents.htm

OECD.org Data Publications More sites News Job vacancies

OECD Data

Road accidents

Related topics
[Energy](#)

Latest publication
[ITF Transport Outlook](#)
 PUBLICATION (2017)

Road accidents are measured in terms of the number of persons injured and deaths due to road accidents, whether immediate or within 30 days of the accident, and excluding suicides involving the use of road motor vehicles. A road motor vehicle is a road vehicle fitted with an engine as the sole means of propulsion and one that is normally used to carry people or goods, or for towing, on the road. This includes buses, coaches, trolleys, tramways (streetcars) and road vehicles used to transport goods and to transport passengers. Road motor vehicles are attributed to the countries where they are registered, while deaths are attributed to the countries in which they occur. This indicator is measured in number of accidents, number of persons, per million inhabitants and million vehicles.

[Less ...](#)

Indicators

- Road accidents
- Passenger transport
- Freight transport
- Container transport
- Passenger car registrations
- Infrastructure investment
- Infrastructure maintenance

Road accidents Deaths, Per 1 000 000 inhabitants, 1994 – 2016

Source: ITF Transport Statistics: Road accidents

Show: [Chart](#) [Map](#) [Table](#) [fullscreen](#) [share](#) [download](#) [My pinboard](#)

https://data.oecd.org/transport/road-accidents.htm

OECD Statistics on Road Fatalities 1994...2016



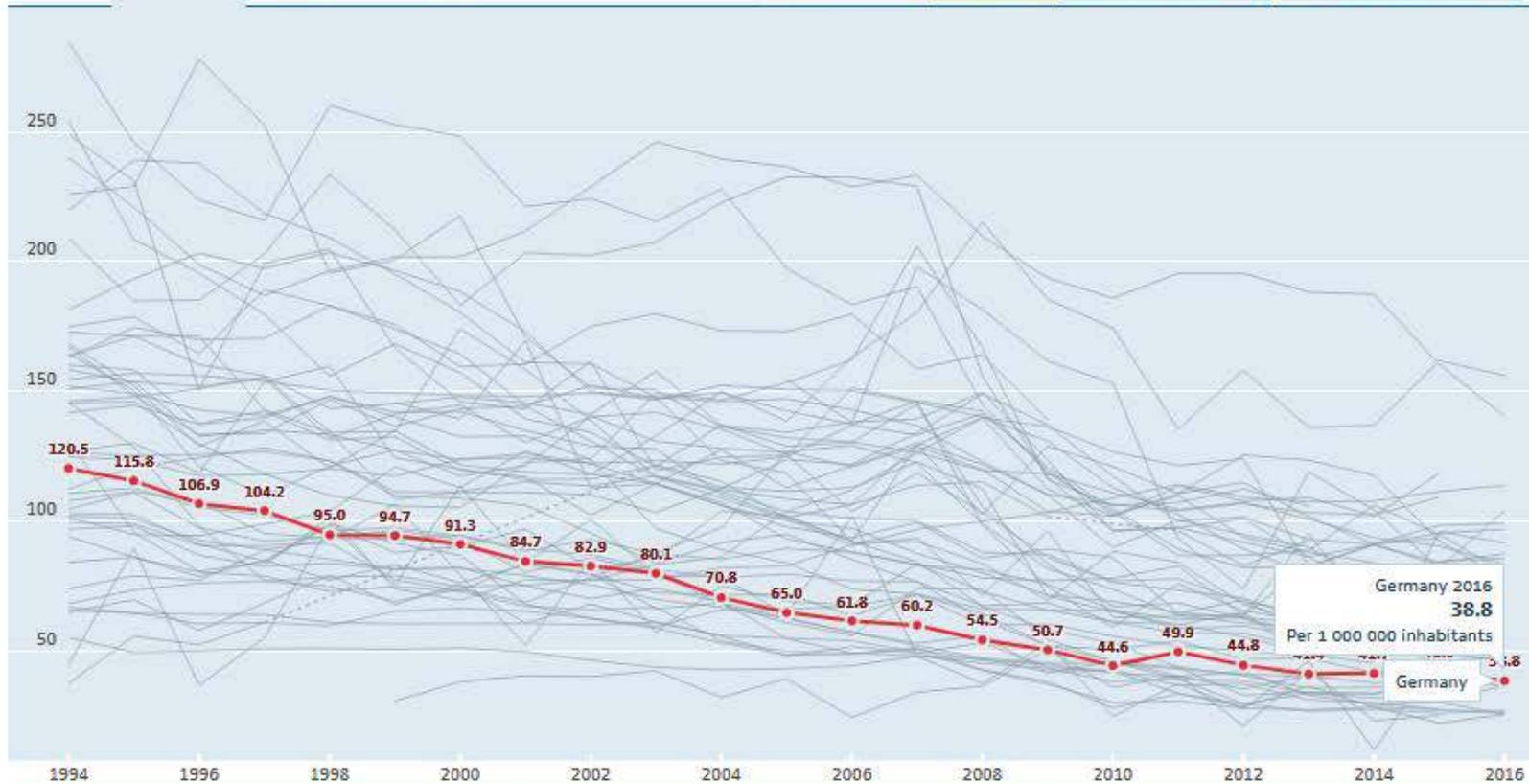
> Français

Search for OECD data



- ⌕ Road accidents
- ⌕ Passenger transport
- ⌕ Freight transport
- ⌕ Container transport
- ⌕ Passenger car registrations
- ⌕ Infrastructure investment
- ⌕ Infrastructure maintenance

Show: **Chart** Map Table fullscreen share download My pinboard



Perspectives

Deaths

Countries

Highlighted Countries (1)

Time

yearly quarterly monthly

Summary

- › **By no investigated item there is any evidence that ECE lighting is negative to traffic safety.**
- › **There is no evidence that US is due to absence of ADB better than ECE**
- › **ADB already contributes to traffic safety**
- › **The general task for all of us is to make the benefits to traffic safety more transparent than it is now.**

ADB, Market and Digitalization Research

ADB today

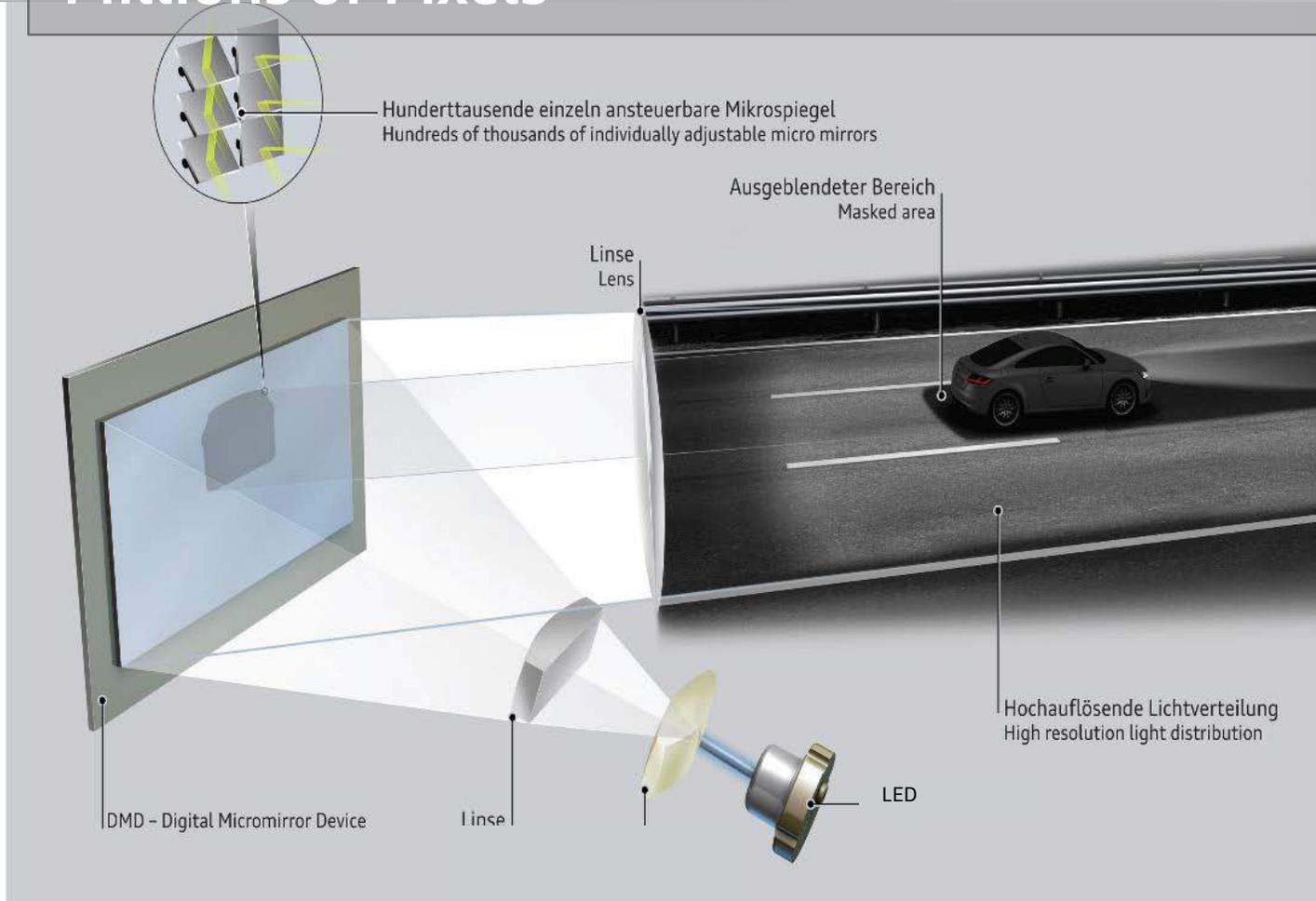
- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

NEXT SAFETY DISCUSSION: Digitalisation

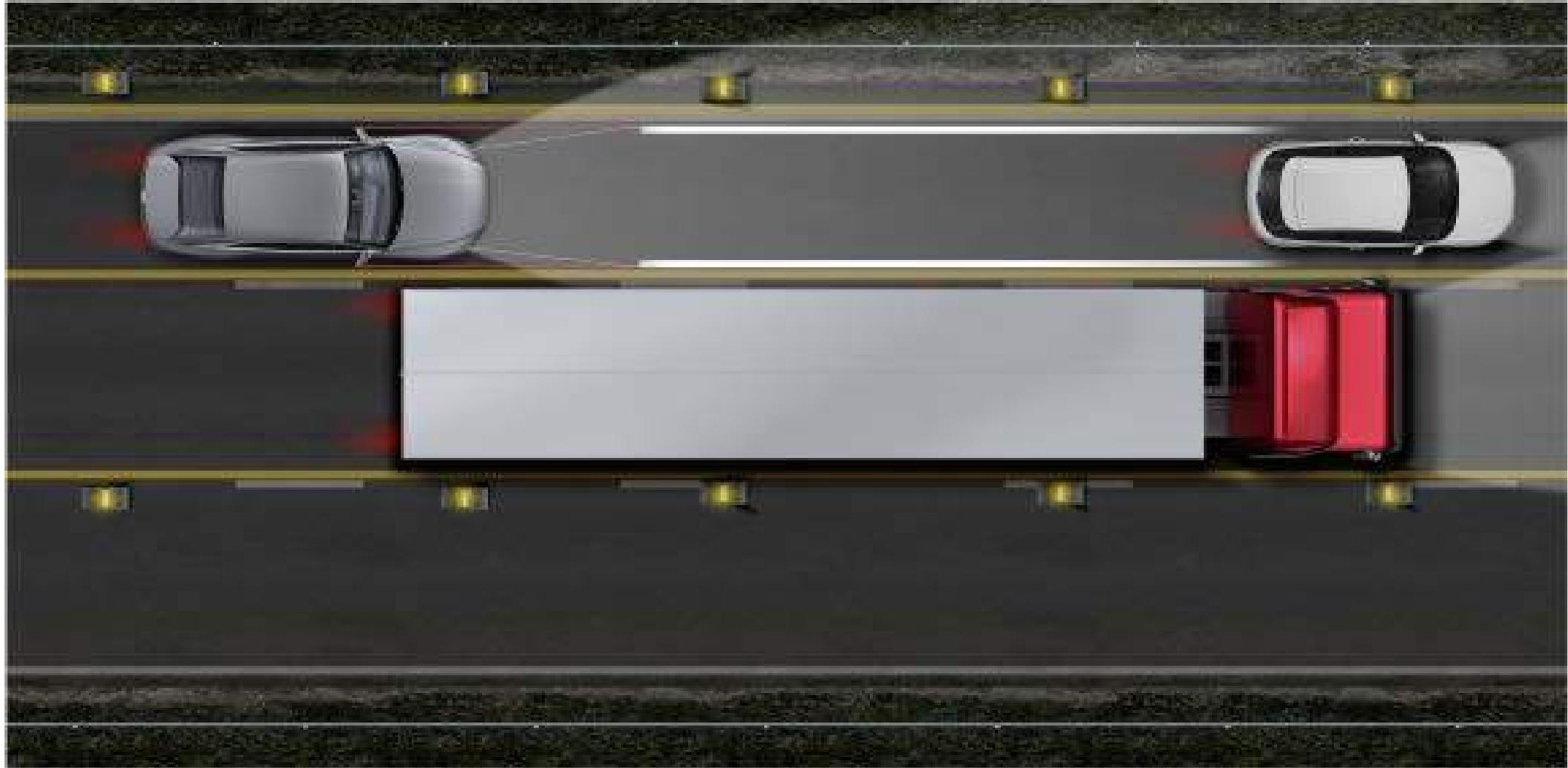
Ten-thousands, hundred-thousands , Millions of Pixels



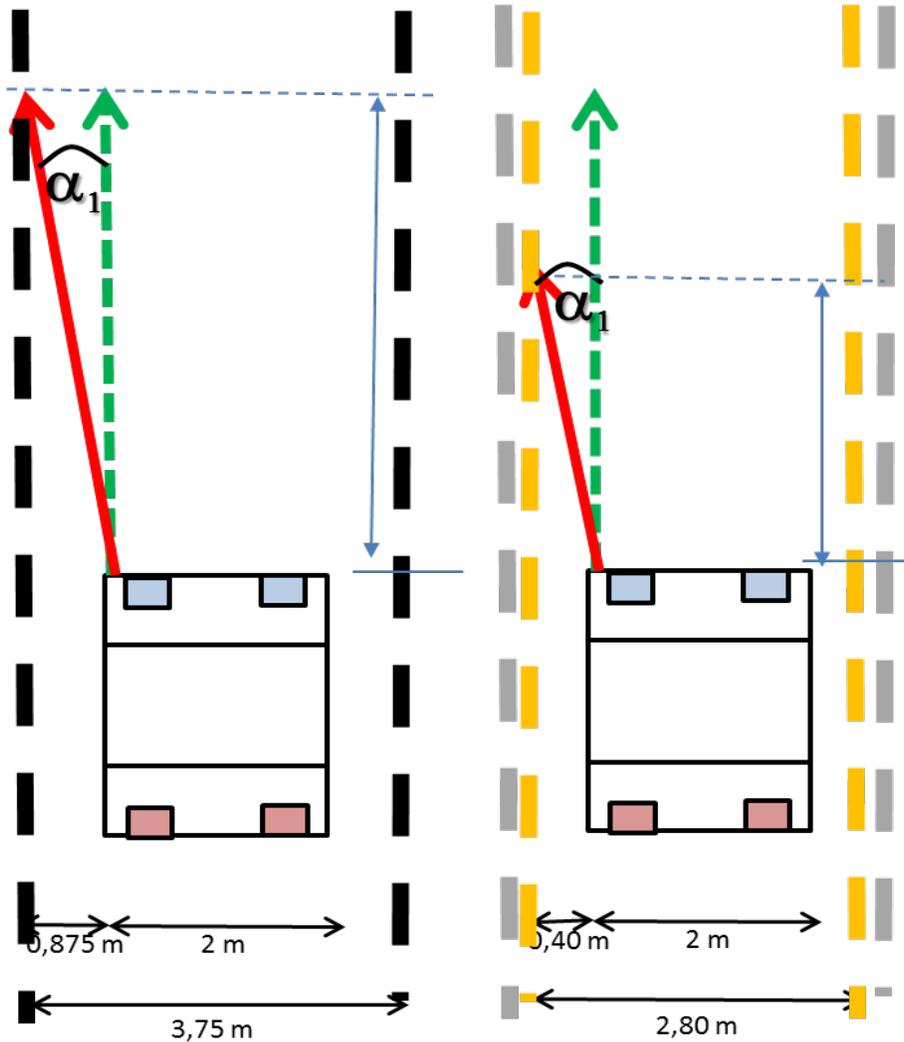
Construction Zone Light (CZL)



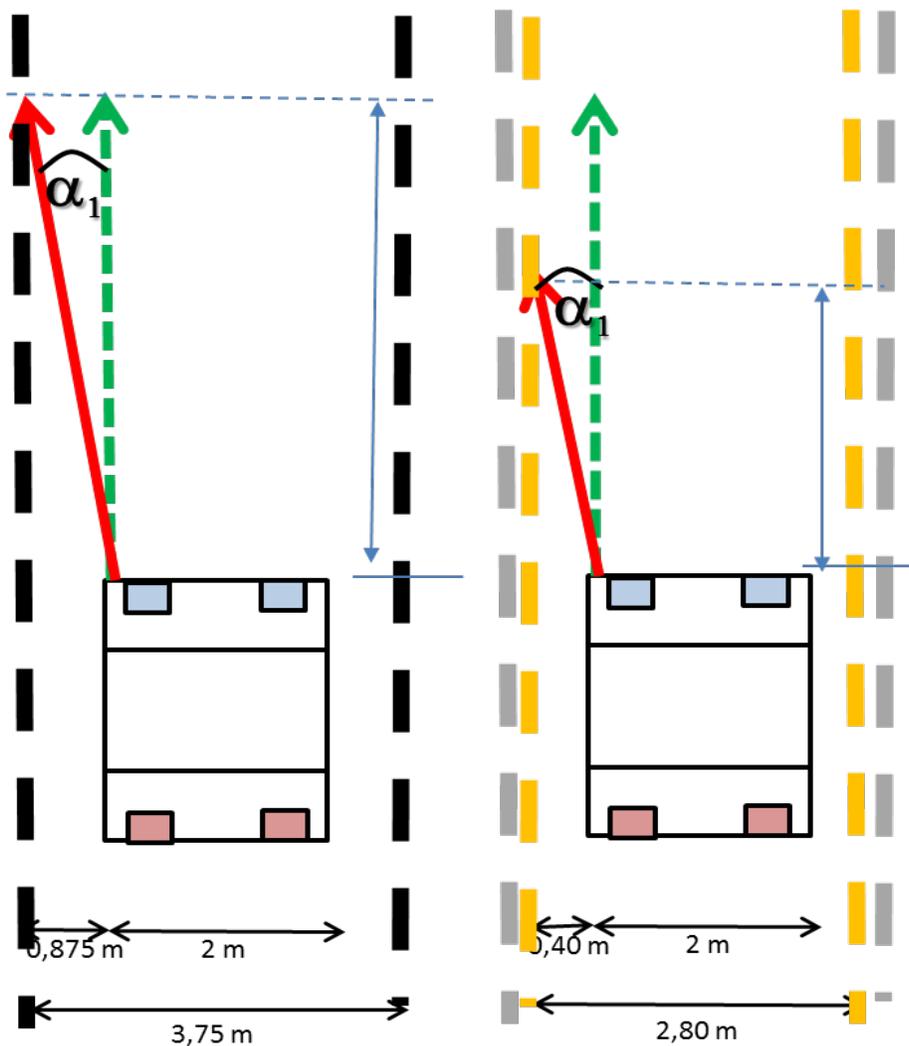
Construction Zone Light (CZL)



Construction Zone Light (CZL)

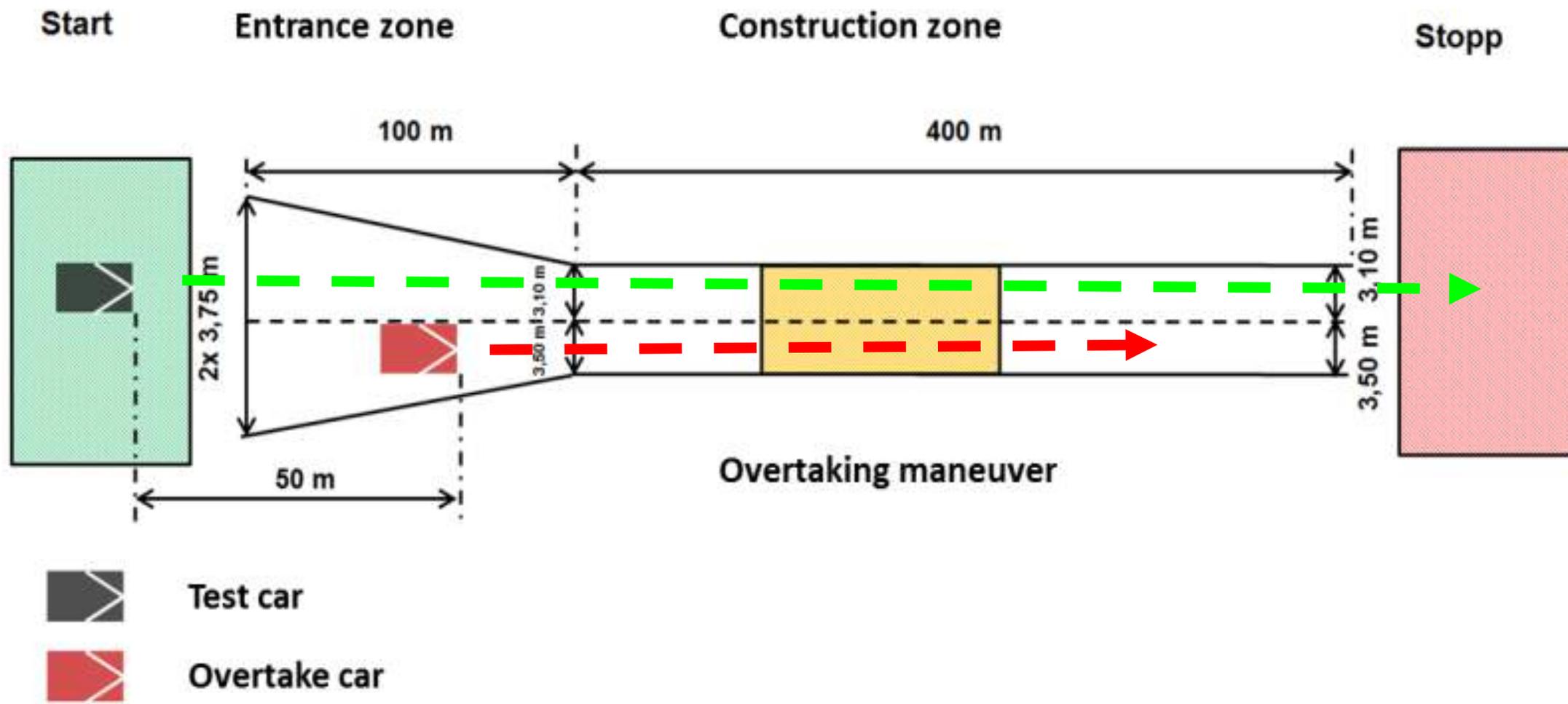


Construction Zone Light (CZL)

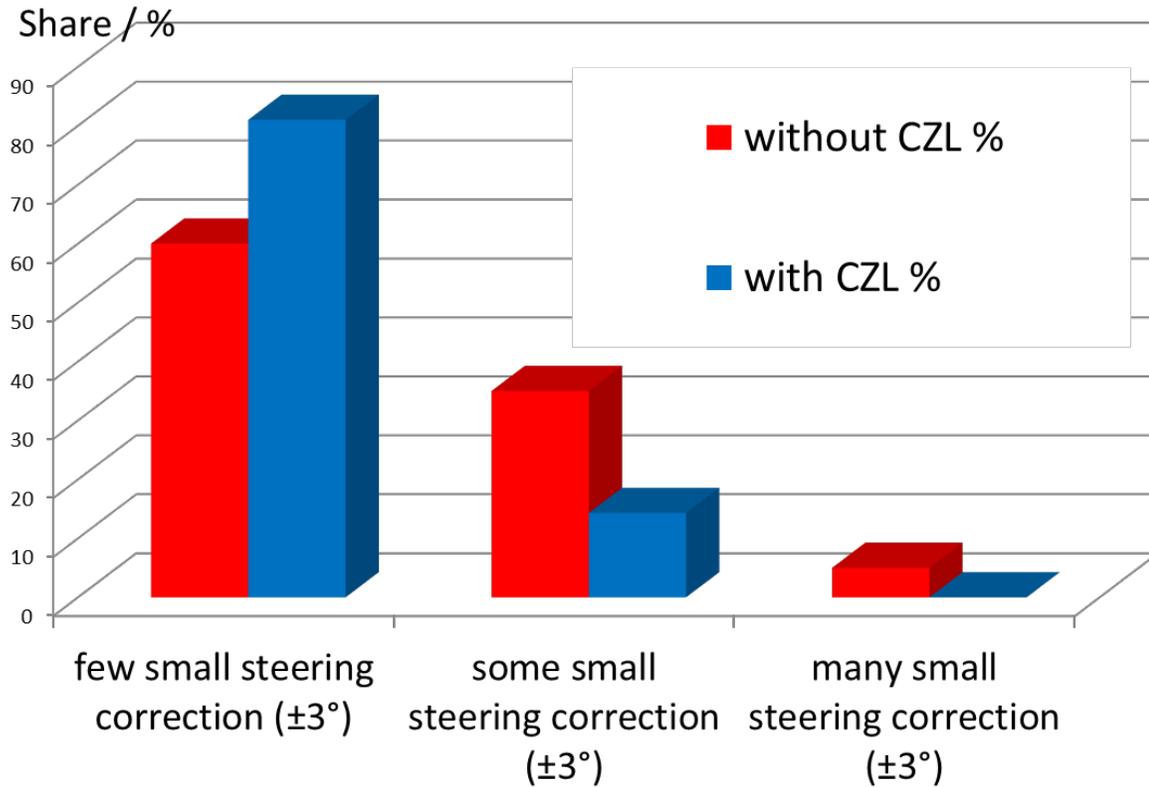


	Normal Lane	Construction Zone
Lane Gap Delta / m	0,875	0,4
steering delta α / °	3	3
travelling distance / m	16,70	7,63
elapsed time / s @ 30mph	1,25	0,57
elapsed time / s @ 45mph	0,83	0,38
elapsed time / s @ 60mph	0,63	0,29

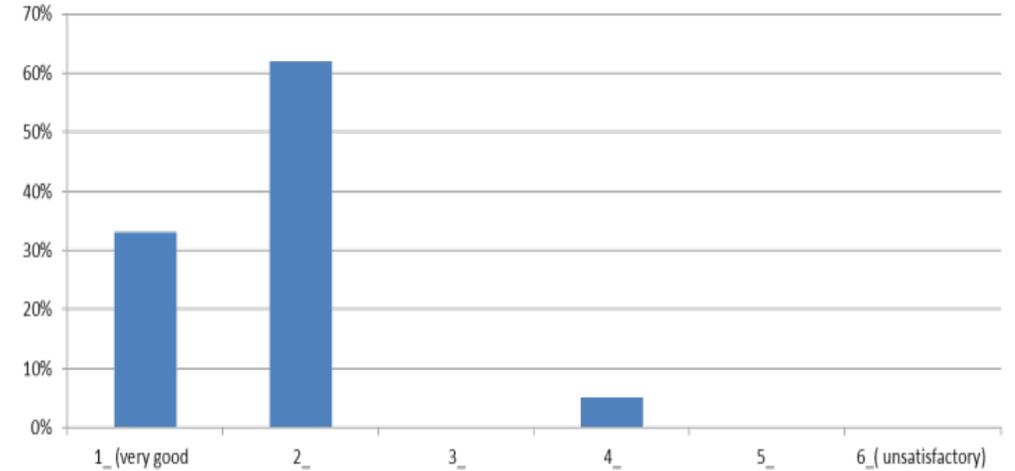
Test Setup Construction Zone Light (CZL)



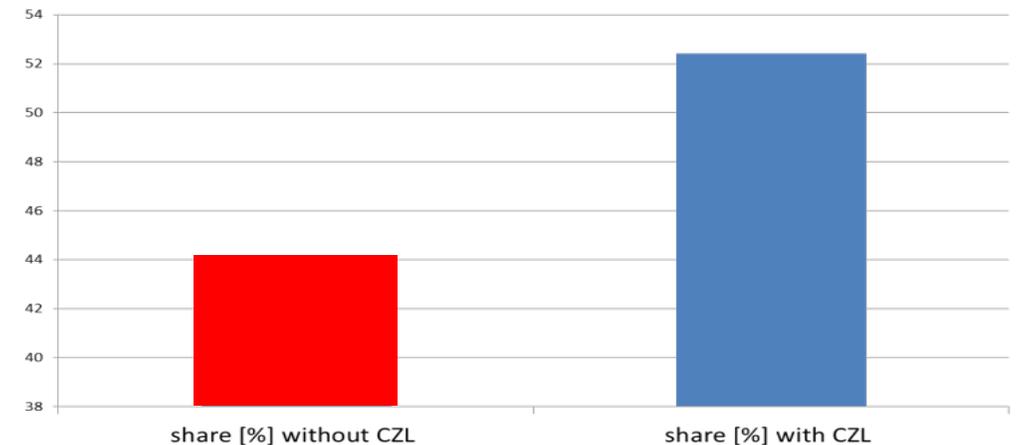
Construction Zone Light (CZL)



Overall opinion on Construction Zone Light (CZL)



constant gas pedal position during takeover



ADB, Market and Digitalization Research

ADB today

- › ADB and NPRM
- › ADB Functionality
- › ECE R123 Measurements
- › ADB in the World Market
- › ADB and traffic safety
- › Safety figures

ADB in Future: Digitalization Research

- › Positive Effects
- › Investigation on Distraction

Study on Potential Distraction of HR Symbol Projections on the Road

Dmitrij Polin, FGLT Darmstadt, 2018



TECHNISCHE
UNIVERSITÄT
DARMSTADT



FACHGEBIET
LICHTTECHNIK



Objectives

Safety

- Do projections distract other road users?
- In what situations is it likely to happen?

Approach

- Evaluation of distraction in an objective manner
- Subjective opinion about projections from the non-user point of view



Eye Tracking System

Evaluation of distraction in an objective manner



SmartEye

4 cameras gaze behavior

Installed in a car of TU Darmstadt

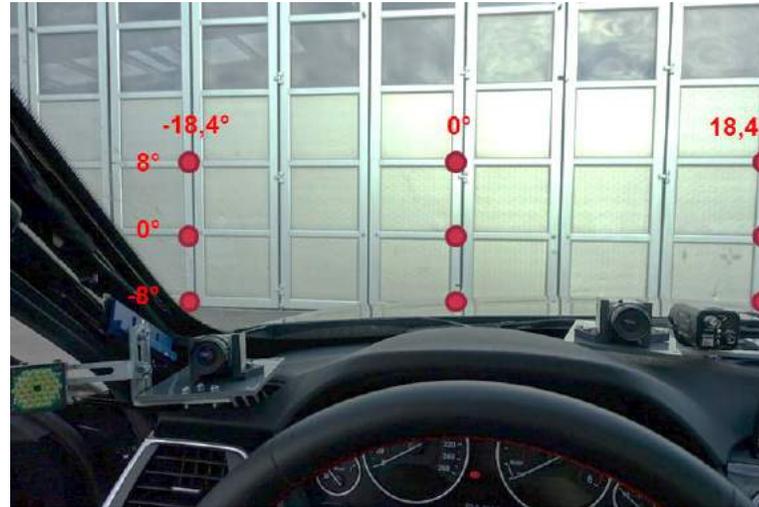
Gaze tracking

Head position tracking

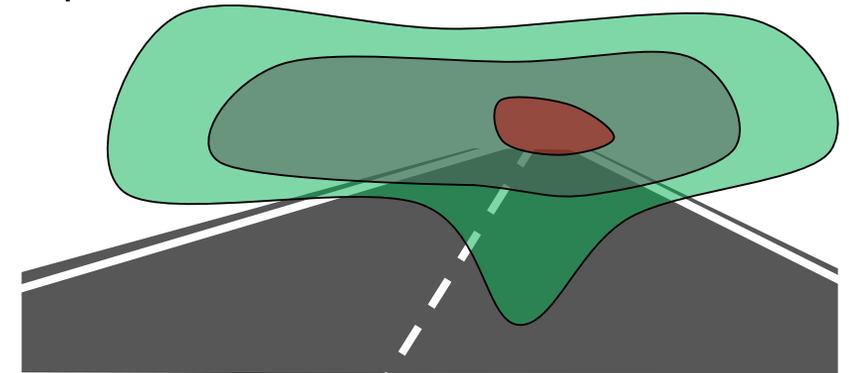
Data rate 60 / 120 Hz

IR illumination

1 scene camera



Eye tracking system and calibration pattern

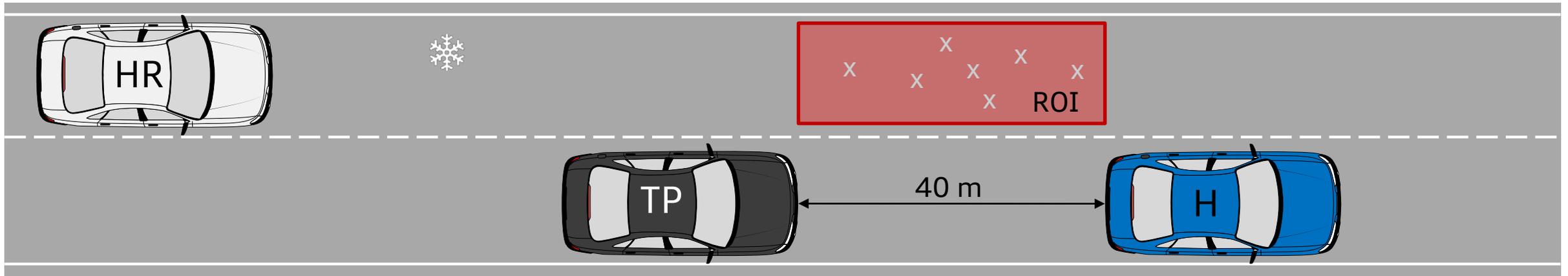


Example of gaze distribution

Case 1: Vehicle with HR headlights projects symbols while overtaking other vehicles – ROI



Case 1: Design of Experiment



HR vehicle

- > Overtaking @ 100 km/h
- > Random order
 - > Snowflake
 - > Guiding lines
 - > Construction site
 - > Low beam

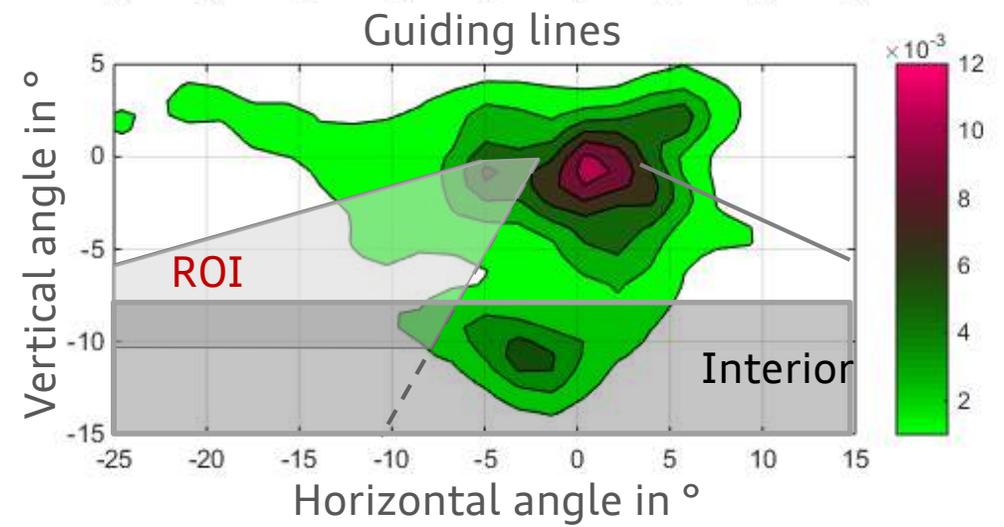
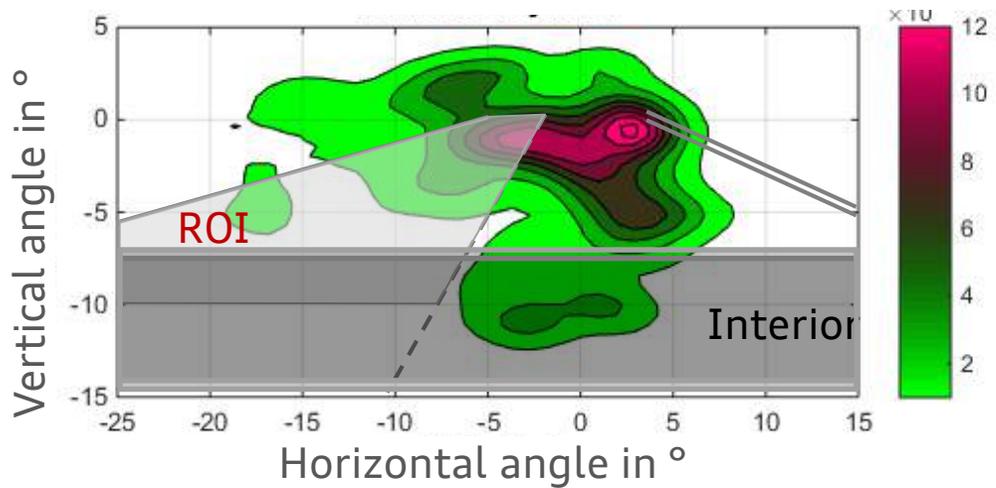
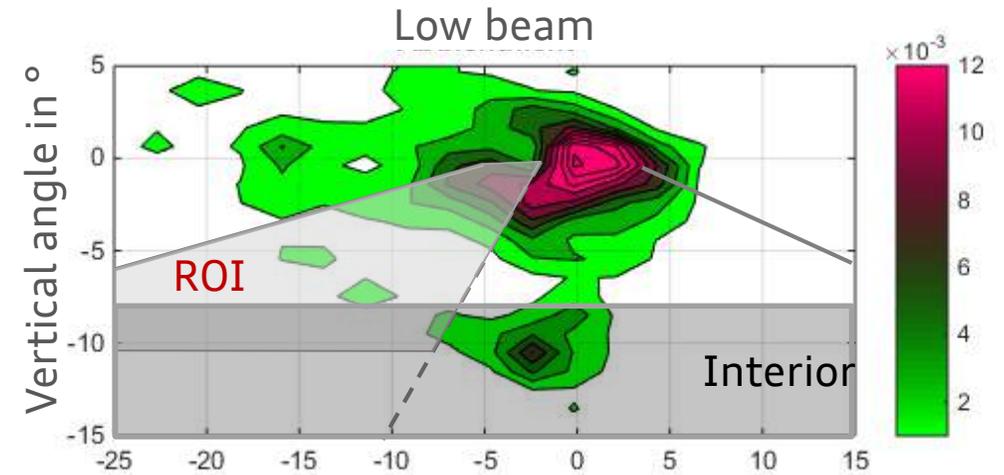
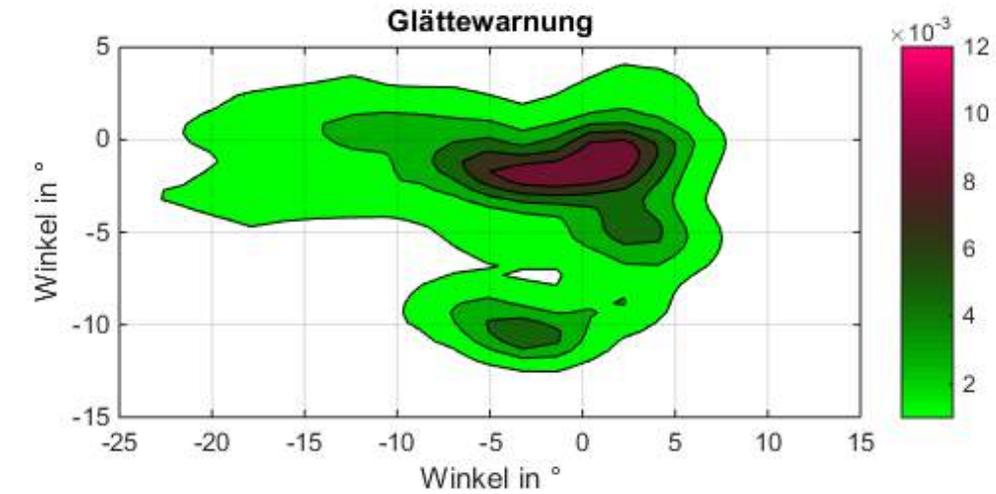
TP vehicle

- Subject driving
- Following H
- Gaze behavior
- Fixations in ROI
- Test instructor

H vehicle

- Preceding
- Constant speed 80 km/h

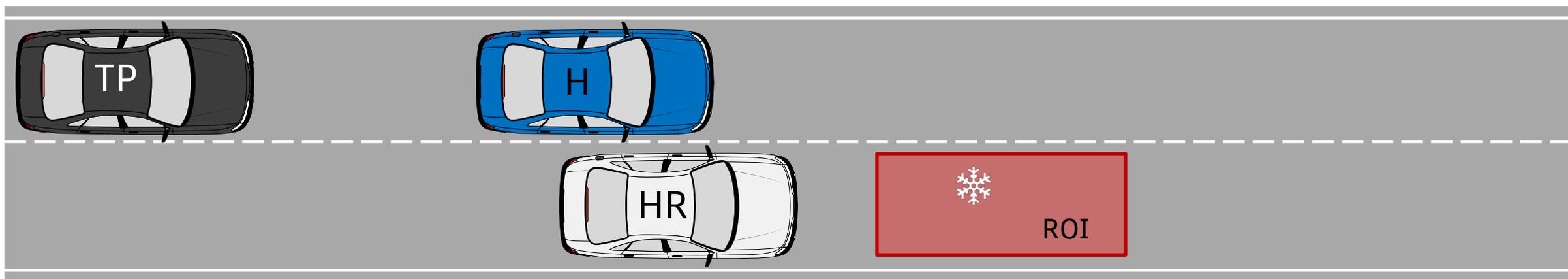
Case 1: Gaze Density Distribution



Case 2: Other vehicles overtake vehicle with HR headlamps projecting symbols – ROI



Case 2: Design of Experiment



HR vehicle

- **Constant speed 80 km/h**
- Random order
 - Snowflake
 - Guiding lines
 - Construction site
 - Low beam

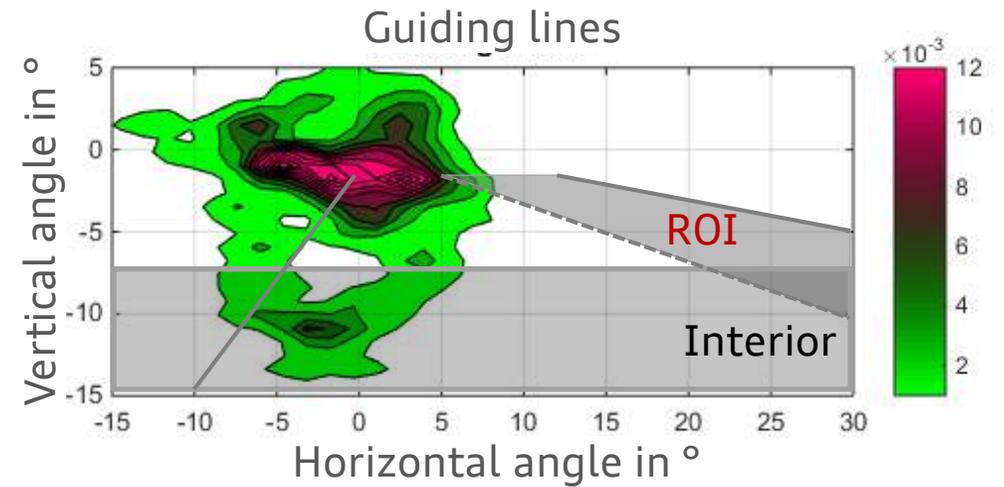
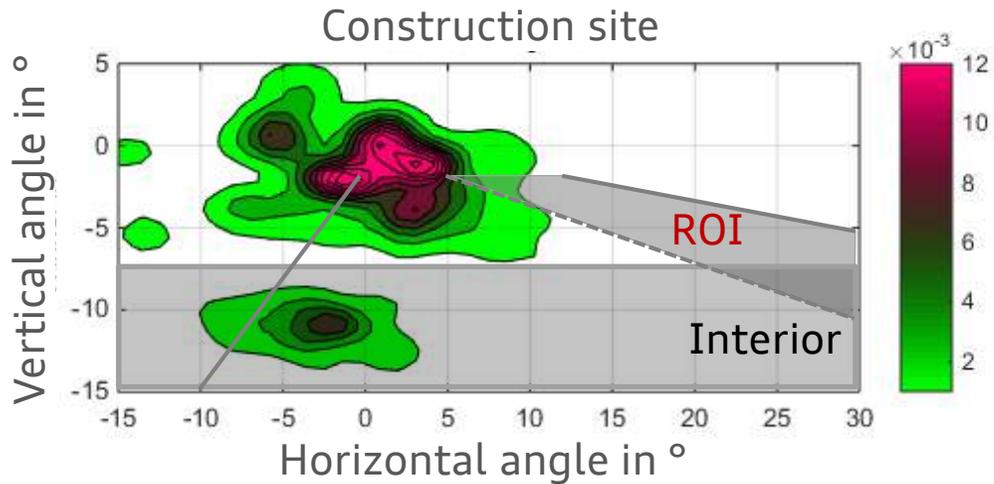
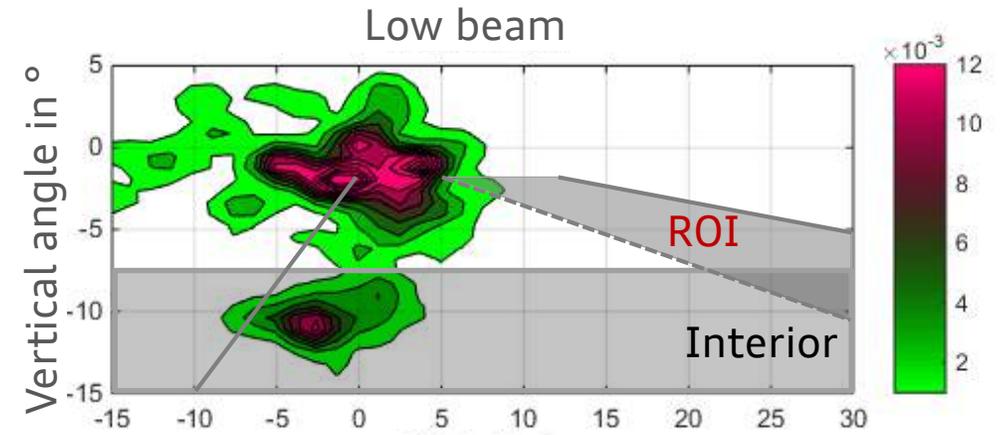
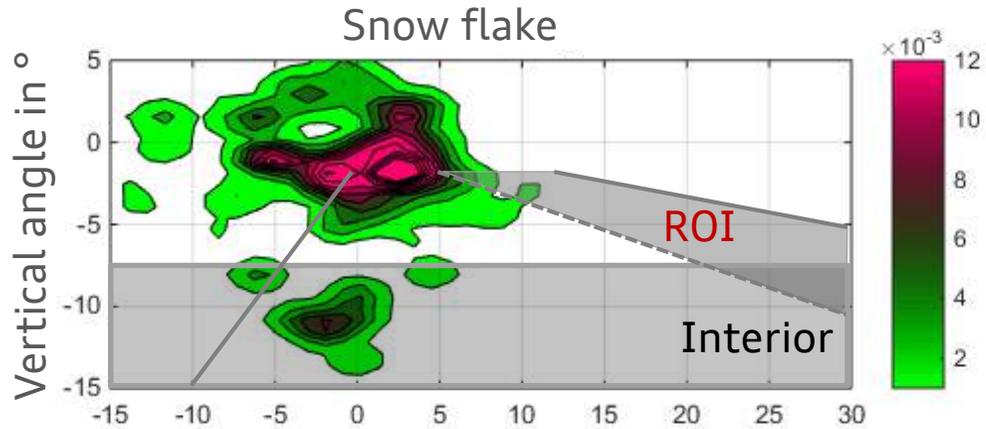
TP vehicle

- Subject driving
- Following H at 40 m
- Gaze behavior
- Fixations in ROI
- Test instructor

H vehicle

- Preceding
- **Overtaking @ 100 km/h**

Case 2: Gaze Density Distribution



Summary

- › **ADB is our future technology.**
- › **How are the bets: When will ADB come in the US ?**
- › **Estimate: ADB will come**

- › **Future technologies are coming, giving more possibilities**

- › **Our arguments how this improves traffic safety have to be improved**

**Thank you for your
attention!**